

CLAIMS

What is claimed is:

- 1 1. A magnetic head having an air bearing surface (ABS), comprising:
2 a free layer; and
3 an antiparallel (AP) pinned layer structure spaced apart from the free layer, the
4 AP pinned layer structure including at least two AP-pinned layers having
5 magnetic moments that are self-pinned antiparallel to each other, the AP-
6 pinned layers being separated by an AP coupling layer;
7 wherein an easy axis of a first of the AP-pinned layers is oriented at an angle of at
8 least 5° from the ABS along a plane of the first AP-pinned layer.

- 1 2. A head as recited in claim 1, wherein an easy axis of each of the AP-pinned layers
2 is oriented at an angle of at least 5° from the ABS along a plane of the associated
3 AP-pinned layer.

- 1 3. A head as recited in claim 1, wherein the easy axis of the first AP-pinned layers is
2 oriented at an angle of between about 30° and about 60° from the ABS along a
3 plane of the first AP-pinned layer.

- 1 4. A head as recited in claim 1, wherein the easy axis of the first AP-pinned layer is
2 oriented at an angle of between about 40° and about 50° from the ABS along a
3 plane of the first AP-pinned layer.
- 1 5. A head as recited in claim 1, wherein easy axes of the AP pinned layers are
2 oriented at about the same angle.
- 1 6. A head as recited in claim 1, wherein easy axes of the AP pinned layers are
2 oriented at different angles.
- 1 7. A head as recited in claim 1, wherein the easy axis is set by forming the first AP-
2 pinned layer in the presence of an applied magnetic field having flux oriented at
3 an angle of at least 5° from the ABS along the plane of the first AP-pinned layer.
- 1 8. A head as recited in claim 1, wherein the AP pinned layer structure is self pinned,
2 the AP pinned layer structure not being stabilized by an antiferromagnet.
- 1 9. A head as recited in claim 1, wherein the magnetizations of the AP-pinned layers
2 are oriented perpendicular to the ABS.
- 1 10. A head as recited in claim 1, further comprising an AFM layer.

- 1 11. A head as recited in claim 11, wherein the easy axis of the first AP-pinned layer is
2 oriented at an angle of between about 5° and about 45° from the ABS along a
3 plane of the first AP-pinned layer.
- 1 12. A head as recited in claim 1, wherein the head is a CPP GMR sensor.
- 1 13. A head as recited in claim 1, wherein the head is a CPP tunnel valve sensor.
- 1 14. A head as recited in claim 1, wherein the head is a CIP sensor.
- 1 15. A magnetic head having an air bearing surface (ABS), comprising:
2 a free layer; and
3 an antiparallel (AP) pinned layer structure spaced apart from the free layer, the
4 AP pinned layer structure including at least two AP-pinned layers having
5 magnetic moments that are self-pinned antiparallel to each other, the AP-
6 pinned layers being separated by an AP coupling layer;
7 wherein the easy axes of the AP-pinned layers are oriented at an angle of between
8 about 30° and about 60° from the ABS along a plane of the associated AP-
9 pinned layer.
- 1 16. A head as recited in claim 15, wherein the easy axis of each of the AP-pinned
2 layers is oriented at an angle of between about 40° and about 50° from the ABS
3 along a plane of the associated AP-pinned layer.

1 17. A head as recited in claim 15, wherein the angle of each of the easy axes is about
2 the same.

1 18. A head as recited in claim 15, wherein the angles of the easy axes are different.

1 19. A head as recited in claim 15, wherein the easy axis is set by forming the AP-
2 pinned layers in the presence of an applied magnetic field having flux oriented at
3 an angle of between about 30° and about 60° from the ABS along the plane of the
4 first AP-pinned layer.

1 20. A head as recited in claim 15, wherein the AP pinned layer structure is self
2 pinned, the AP pinned layer structure not being stabilized by an antiferromagnet.

1 21. A head as recited in claim 15, wherein the magnetizations of the AP-pinned layers
2 are oriented perpendicular to the ABS.

1 22. A head as recited in claim 15, further comprising an AFM layer.

1 23. A head as recited in claim 22, wherein the easy axis of the first AP-pinned layer is
2 oriented at an angle of between about 5° and about 45° from the ABS along a
3 plane of the first AP-pinned layer.

- 1 24. A head as recited in claim 15, wherein the head is a CPP GMR sensor.
- 1 25. A head as recited in claim 15, wherein the head is a CPP tunnel valve sensor.
- 1 26. A head as recited in claim 15, wherein the head is a CIP sensor.
- 1 27. A magnetic storage system, comprising:
2 magnetic media;
3 at least one head for reading from and writing to the magnetic media, each head
4 having:
5 a free layer; and
6 an antiparallel (AP) pinned layer structure spaced apart from the free
7 layer, the AP pinned layer structure including at least two AP-
8 pinned layers having magnetic moments that are self-pinned
9 antiparallel to each other, the AP-pinned layers being separated by
10 an AP coupling layer;
11 wherein an easy axis of a first of the AP-pinned layers is oriented at an
12 angle of at least 5° from the ABS along a plane of the first AP-
13 pinned layer;
14 a slider for supporting the head; and
15 a control unit coupled to the head for controlling operation of the head.